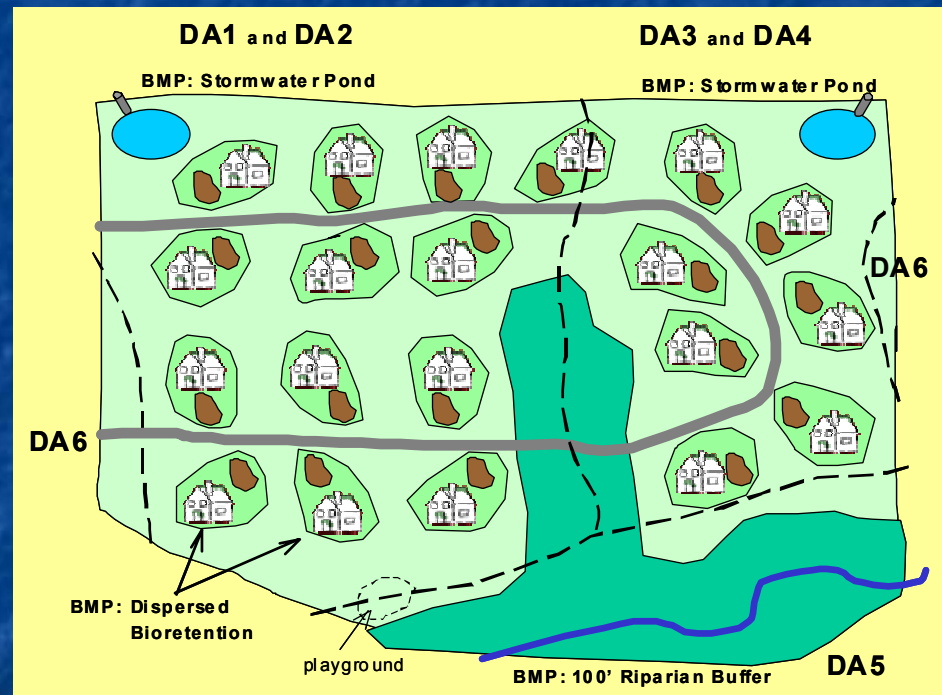


The Site Evaluation Tool (SET): A Means to Implementing Performance Standards as an Alternative to Prescriptive Ordinance Provisions



By Trevor Clements, Scott Job, and
Kimberly Brewer



TETRA TECH, INC.

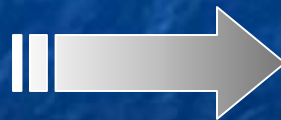
Increasing Challenge of Managing Stormwater Runoff

- Protecting WQ means addressing NPS
- New development is the primary source



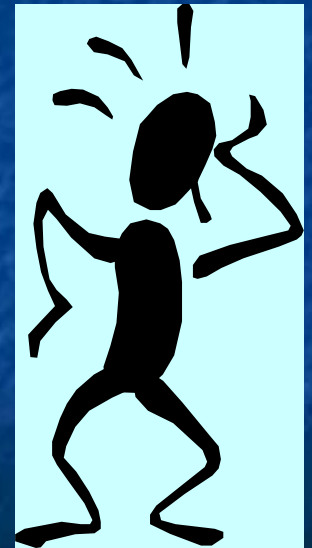
Commonly Applied Solution = Prescriptive Ordinance Provisions

- Examples
 - Fixed imperviousness limits
 - Fixed housing densities (e.g., 1 house/2 acres)



Drawbacks of Prescriptive Approach

- Increase in urban sprawl
- Lack of diversity in development type
- Reputation for inflexibility
- Can unintentionally lead to greater environmental impacts



Alternative = Performance Standards

- Measures that specify desired outcomes
 - Runoff volume reduction
 - Detention/retention
 - Pollutant load reductions

**Percent
Removal**

**Areal Loading
Rate Cap**

**Match Pre-
Construction
Hydrograph**

Past Barrier



- Perceived cost of administration:

How can local plan review agencies evaluate the ability of site plans to achieve performance standards?

Solution = Site Evaluation Tool (SET)

- Excel-based spreadsheet tool
- Provides quick, technically-valid basis for evaluating site development impacts
 - easy to use and administer
 - compare alternative designs and BMPs
- Basis for determining compliance with performance standards
- Easily distributed to development community

SET Functions

- Impact of land use conversion on
 - annual runoff and infiltration
 - storm event runoff
 - annual pollutant loading
- Assess BMP influence on hydrology and pollutant loads
- Compare site performance to targets/standards

Key impacts to address

- Runoff volume
 - Stream power to cause downstream channel erosion (impact on peak flow and hydrograph)
- Upland pollutant loading
 - Sediment
 - Nutrients (N and P)
 - Fecal Coliform Bacteria



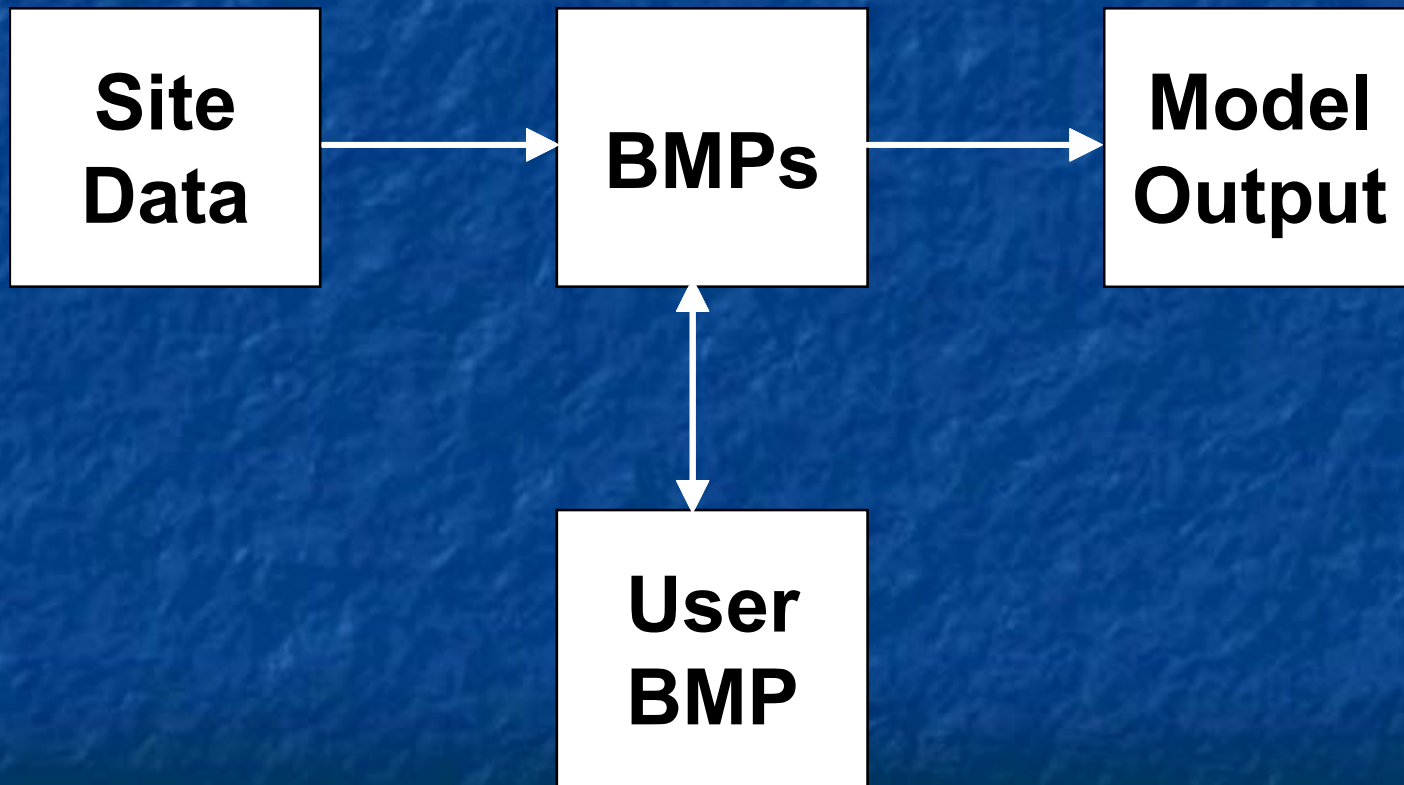
Models used in SET

- Annual pollutant loads, runoff, infiltration
 - Modified SUNOM - combines SIMPLE method for runoff/infiltration with event mean concentrations; enhanced to evaluate multiple land types
- Storm event runoff
 - NRCS TR-55 Curve Number approach
 - runoff volume
 - peak flow
 - unit hydrograph method to generate composite hydrograph for site

Tour of SET



User works with four spreadsheets



Site Data Sheet

General Information	
Name of Applicant:	Company Name
Name of Project:	Project Name
Scenario Name*:	LID Design
# Homes on Septic Systems	
Unsewered Commercial Systems (gal/yr)	
Development Site Area (acres):	71.235
Development Site Area (calculated, ft ²):	3,102,997

Soil Hydrologic Groups (Percent of Site Area)	
Group A	
Group B	18.60%
Group C	81.40%
Group D	

Design Storm for Runoff Calculation
<input type="checkbox"/> 2-year Storm (Rural and Transitional Zones)
<input checked="" type="checkbox"/> 1-year Storm (All Other Zones)

Site Data Sheet (cont.)

Land Use/Cover Data				
	Existing Land Use		Proposed Land Use	
	Area (ft ²)	% of Site	Area (ft ²)	% of Site
Pervious Areas				
Row Crops		0.0%		0.0%
Pasture		0.0%		0.0%
Forest	1,110,971	35.8%	24,438	0.8%
Wetland		0.0%		0.0%
Meadow	1,911,073	61.6%		0.0%
Lawn		0.0%	2,101,009	67.7%
Impervious Areas				
Residential & Light Industrial				
Rooftops		0.0%	502,162	16.2%
Driveways & Parking Lots		0.0%	96,542	3.1%
Other Impervious Area		0.0%		0.0%
Road		0.0%	290,813	9.4%
Sidewalk		0.0%	43,253	1.4%
Commercial & Heavy Industrial				
Rooftops		0.0%		0.0%
Parking Lot		0.0%		0.0%
Other Impervious Area		0.0%		0.0%
Road		0.0%		0.0%
Sidewalk		0.0%		0.0%
Storm Water Management Facilities				
Pond/Wetland	80,953	2.6%	44,780	1.4%
All Other BMPs (except Forested Buffer)		0.0%		0.0%
Site Totals:	3,102,997	100.0%	3,102,997	100.0%
Total Site Impervious Cover	2.6%		31.5%	
Impervious Cover within Developed Area	100.0%		31.8%	

BMPs Sheet

Proposed Land Use/ Cover Data by DA					
	Project Areas (ft ²)	Unassigned Area (ft ²)			
			DA1	DA2	DA3
Pervious Areas					
Row Crops	0	0			
Pasture	0	0			
Forest	24,438	0			24,438
Wetland	0	0			
Meadow	0	0			
Lawn	2,101,009	0	1,588,203	163,567	349,239
Impervious Areas					
Residential & Light Industrial					
Rooftops	502,162	0	448,819	43,765	9,578
Driveways & Parking Lots	96,542	0	96,542		
Other Impervious Area	0	0			
Road	290,813	0	290,813		
Sidewalk	43,253	0	43,253		
Commercial & Heavy Industrial					
Rooftops	0	0			
Parking Lot	0	0			
Other Impervious Area	0	0			
Road	0	0			
Sidewalk	0	0			
Storm Water Management Facilities					
Pond/Wetland	44,780	0			44,780
All Other BMPs (except Forested Buffer)	0	0			
Total Area	3,102,997	0	2,467,630	207,332	428,035

BMPs Sheet (cont.)

BMPs Applied to DA	DA1	DA2	DA3
Wet Pond Phase II	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Wet Pond 1 in storm	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Dry Detention	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Bioretention	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
WQ Swale	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
User-defined BMP (Sequential with other assigned BMPs)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Forested Buffer	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Enter Buffer Width for each DA with Forested Buffer (feet):		100	
Percent of DA within treatment zone:		100.0%	
Storage volume for 1 yr, 24 hr storm (acre-ft)	2.513		

Net Reductions	DA1	DA2	DA3
Flow converted to infiltration by BMPs	0.0%	10.0%	0.0%
Total Nitrogen	51.3%	34.4%	0.0%
Total Phosphorus	55.5%	42.8%	0.0%
TSS	92.1%	66.9%	0.0%
Fecal Coliform	97.8%	5.0%	0.0%

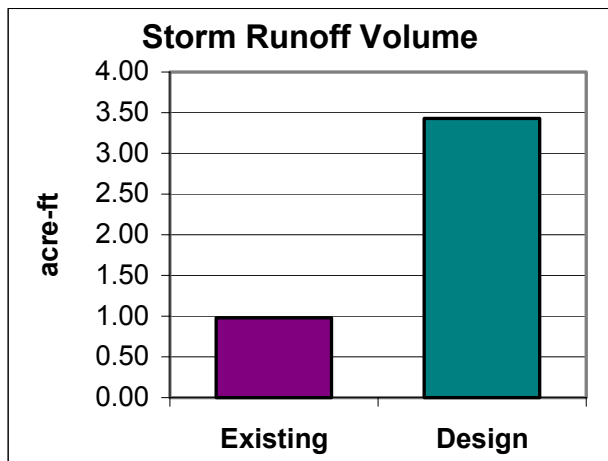
Model Output Sheet - Hydrology

Annual Hydrology Summary

	Existing <u>Landuse</u>	Design <u>without BMPs</u>	Design <u>with BMPs</u>
Annual Surface Runoff (inches/yr)	3.06	13.22	13.16
Annual Infiltration (inches/yr)	6.93	3.91	3.97

1-year, 24-hour Storm Event Runoff Volume Summary

Site located in a zone other than Rural or Transitional Zone



Storm Event Runoff Volume (acre-ft)

Existing Landuse	0.978
Design without BMPs	3.428

On-Site Storage and Target (acre-ft)

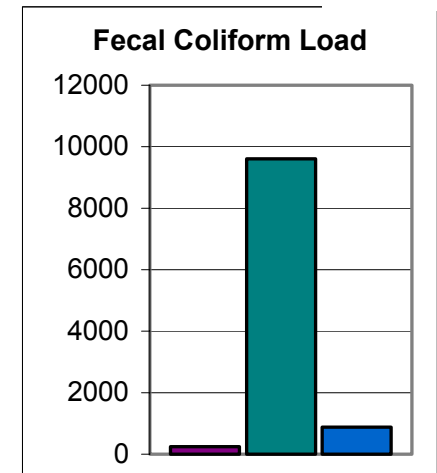
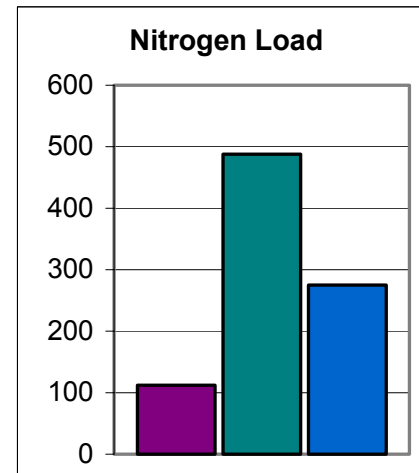
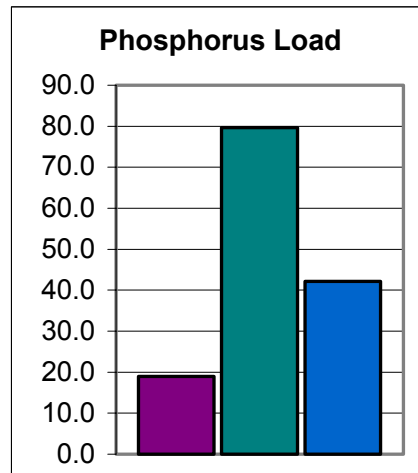
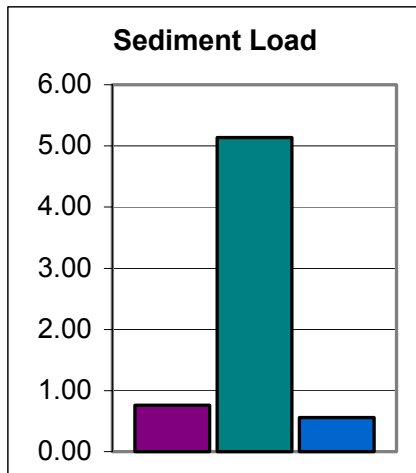
1-year, 24-hour BMP Storage	2.513
Target Storage	2.450
Meets Goal?	Yes

[Note: updated model will show effect of BMPs on peak flow and composite hydrograph]

Model Output Sheet – Pollutant Loads

Annual Pollutant Load Summary

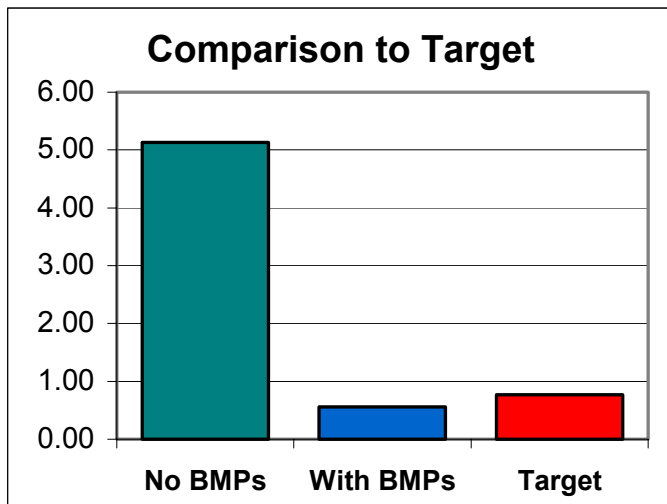
	<u>Existing</u> <u>Landuse</u>	<u>Design</u> <u>without BMPs</u>	<u>Design</u> <u>with BMPs</u>
Sediment (ton/yr)	0.76	5.14	0.56
Total Phosphorus (lb/yr)	18.9	79.6	42.2
Total Nitrogen (lb/yr)	112	488	275
Fecal Coliform (count x 10 ⁹ /yr)	240	9607	880



[Note: updated model will also show effect of BMPs on areal pollutant loading rates, e.g., lb/acre/yr]

Model Output Sheet – Sediment Target

Developed Area Sediment Target Summary



Sediment Loading and Target (ton/yr)

Design without BMPs	5.13
Design with BMPs	0.56
Target Loading	0.77
Meets Goal?	Yes

Additional sediment from undeveloped areas removed by BMPs (for reference only):	0
--	---

BMPs Meet Sediment Load Reduction and Runoff Control Targets

Case Study – Institutional Site

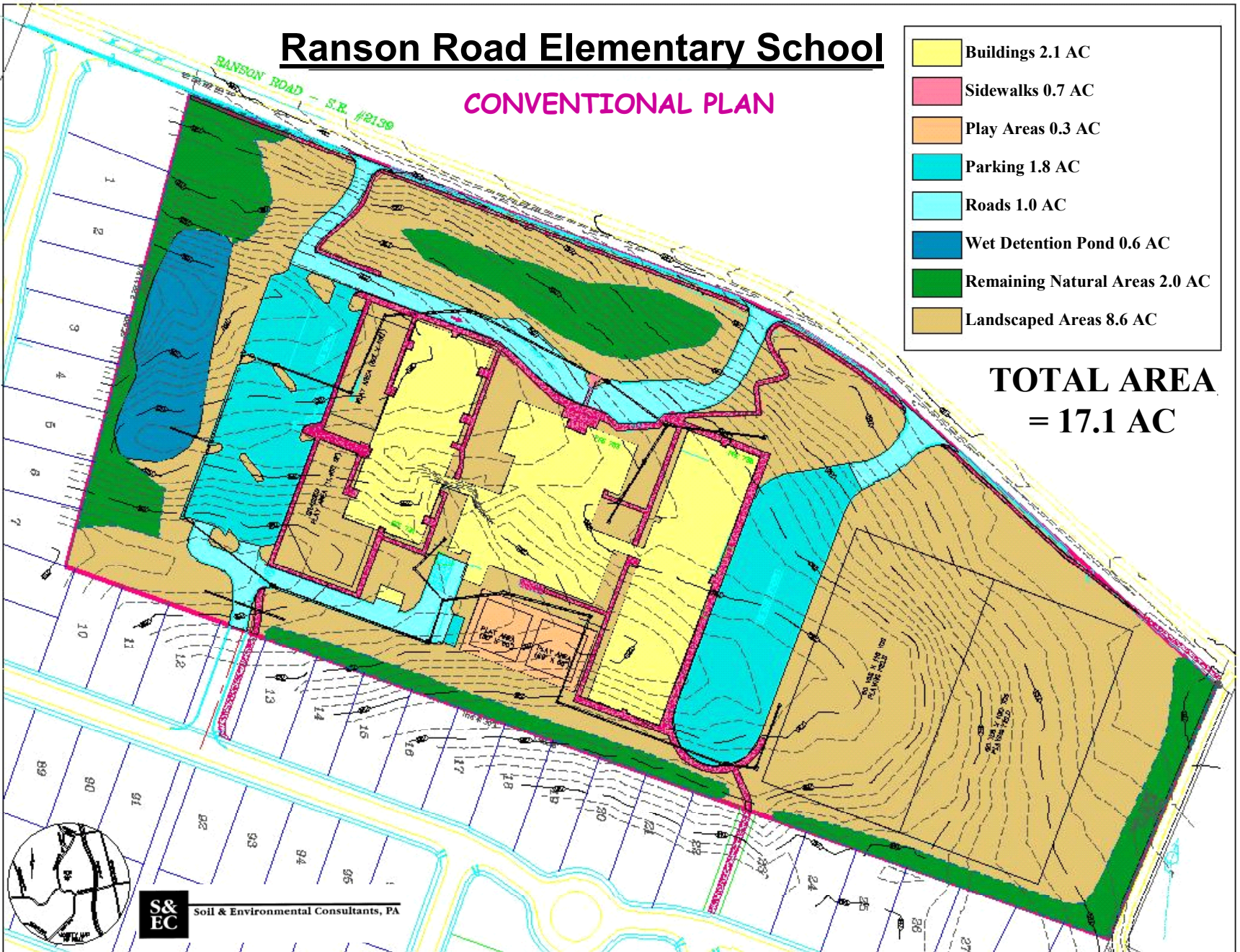
- 17 acre school site (35% impervious)
- Compared conventional design with wet detention pond to LID design with bioretention and dry detention
- Constrained by site footprint

Ranson Road Elementary School

CONVENTIONAL PLAN

	Buildings 2.1 AC
	Sidewalks 0.7 AC
	Play Areas 0.3 AC
	Parking 1.8 AC
	Roads 1.0 AC
	Wet Detention Pond 0.6 AC
	Remaining Natural Areas 2.0 AC
	Landscaped Areas 8.6 AC

TOTAL AREA
= 17.1 AC

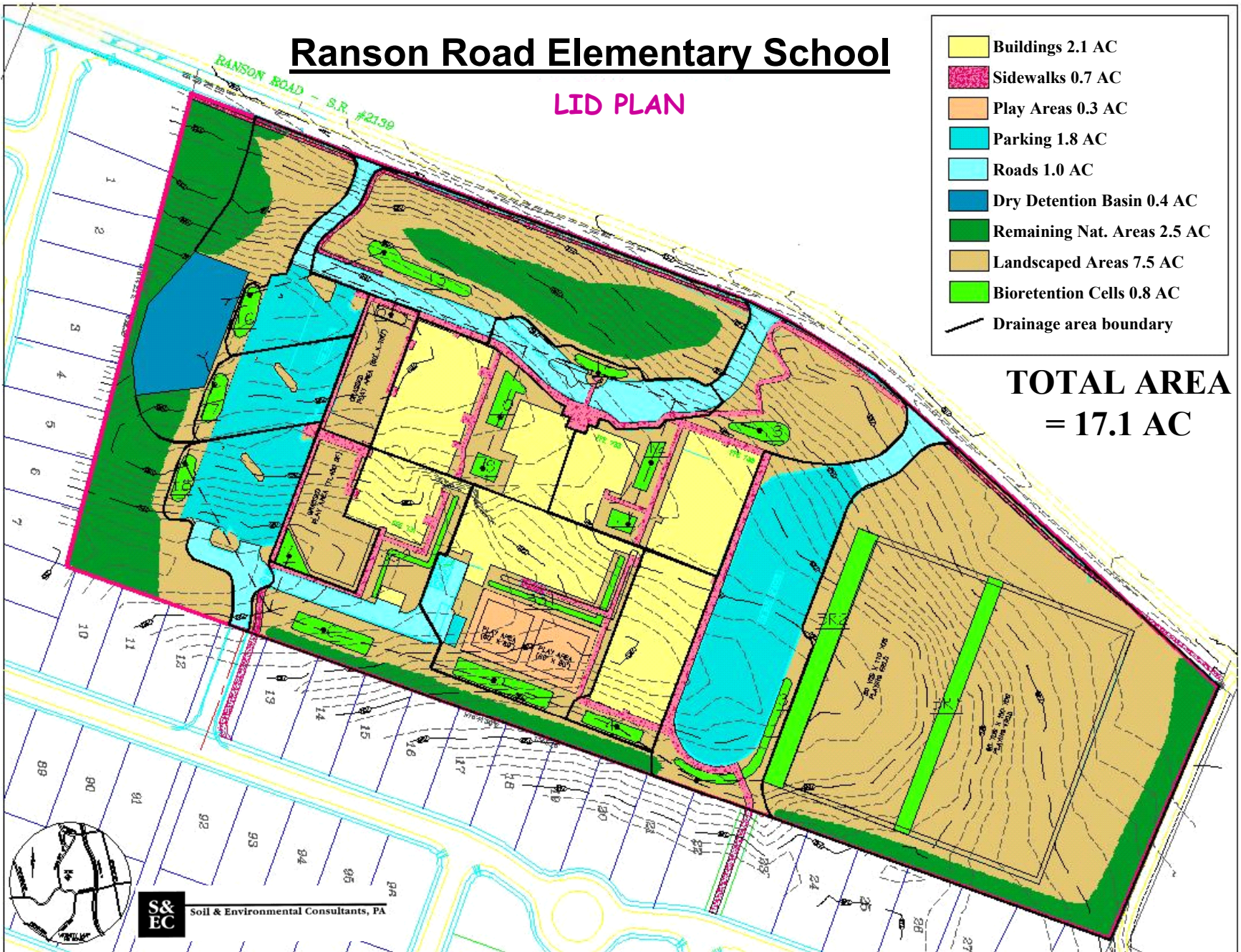


Ranson Road Elementary School

LID PLAN

- Buildings 2.1 AC
- Sidewalks 0.7 AC
- Play Areas 0.3 AC
- Parking 1.8 AC
- Roads 1.0 AC
- Dry Detention Basin 0.4 AC
- Remaining Nat. Areas 2.5 AC
- Landscaped Areas 7.5 AC
- Bioretention Cells 0.8 AC
- Drainage area boundary

**TOTAL AREA
= 17.1 AC**



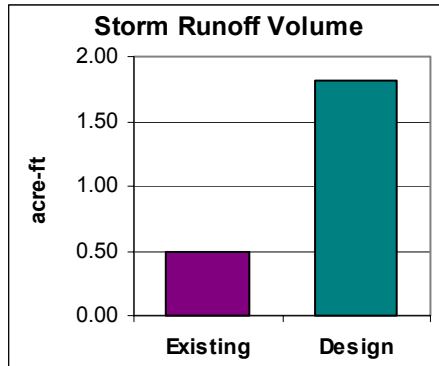
S&EC

Soil & Environmental Consultants, PA

Institutional Site Performance, Conventional Design

2-year, 24-hour Storm Event Runoff Volume Summary

Site located in Rural or Transitional Zone



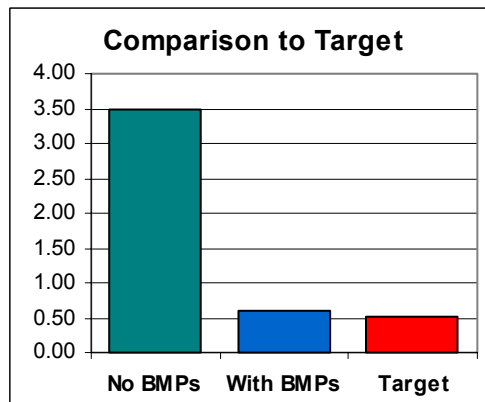
Storm Event Runoff Volume (acre-ft)

Existing Landuse	0.494
Design without BMPs	1.817

On-Site Storage and Target (acre-ft)

2-year, 24-hour BMP Storage	0.566
Target Storage	1.323
Meets Goal?	NO

Developed Area Sediment Target Summary



Sediment Loading and Target (ton/yr)

Design without BMPs	3.48
Design with BMPs	0.59
Target Loading	0.52
Meets Goal?	NO

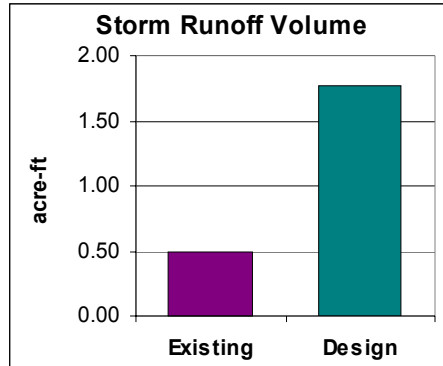
Additional sediment from undeveloped areas removed by BMPs (for reference only): 0.09

Sediment Load Reduction and/or Runoff Control Targets not met by BMPs!!

Institutional Site Performance, LID Design

2-year, 24-hour Storm Event Runoff Volume Summary

Site located in Rural or Transitional Zone



Storm Event Runoff Volume (acre-ft)

Existing Landuse 0.494

Design without BMPs 1.767

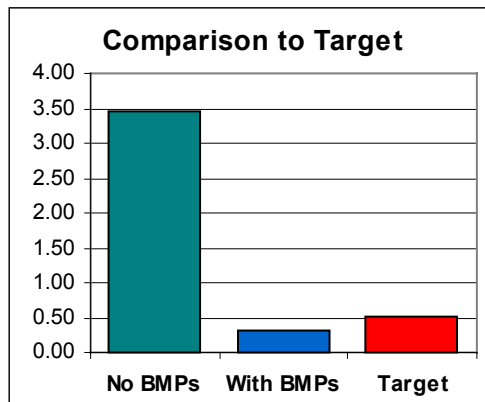
On-Site Storage and Target (acre-ft)

2-year, 24-hour BMP Storage 1.573

Target Storage 1.274

Meets Goal? Yes

Developed Area Sediment Target Summary



Sediment Loading and Target (ton/yr)

Design without BMPs 3.47

Design with BMPs 0.32

Target Loading 0.52

Meets Goal? Yes

Additional sediment from undeveloped areas removed by BMPs (for reference only): 0.08

BMPs Meet Sediment Load Reduction and Runoff Control Targets

Case Study Results

- Conventional design does not meet performance standards, while LID design does
- Dry detention smaller footprint than wet pond, more natural area retained in LID design
- Bioretention to dry detention treatment train improves sediment removal substantially

Summary

- Spreadsheet format easy to use
- Scoping level evaluation
- Addresses multiple parameters of interest
- Allows evaluation of innovative designs and BMP effectiveness
- Can compare results of site design to performance standards

Questions and Discussion

